



## Controlling oxidation in skin care products with novel seaweed antioxidants

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# Controlling oxidation in skin care products with novel seaweed antioxidants

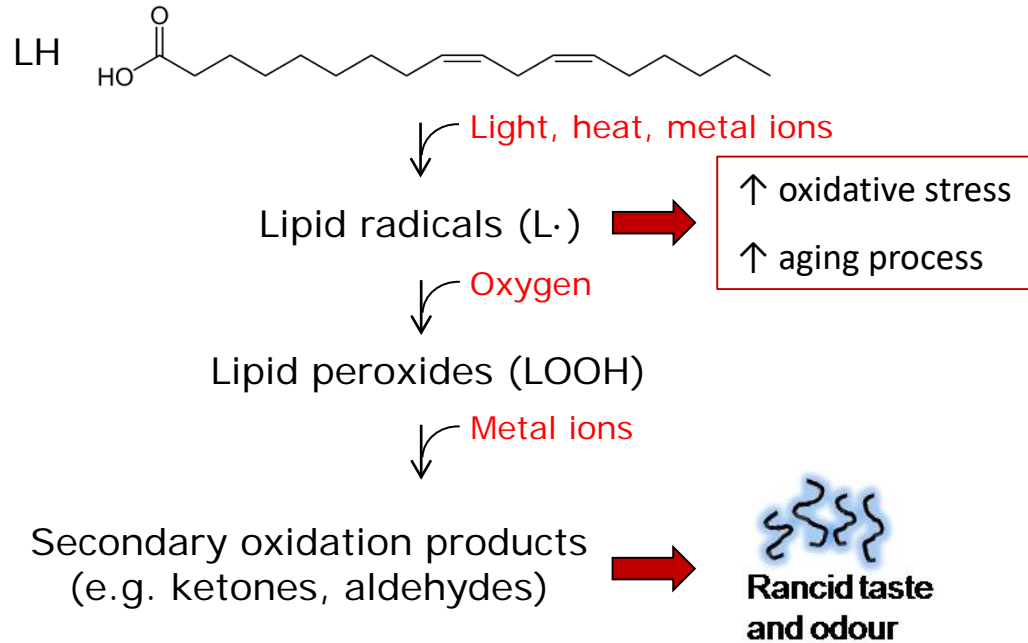
Ditte B. Hermund, Niruja Sivasubramaniam, Shuk Yee Heung, Randi Neerup, Birgitte R. Thomsen & Charlotte Jacobsen

AOCS, 2018



## Product quality and safety issues

## Oxidation of functional lipids in skin care products



## Costumers demands



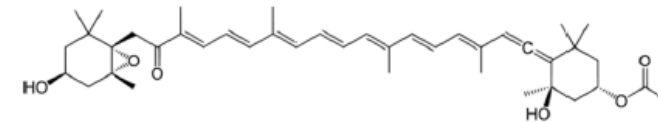
## Solution:

## development of new natural antioxidants

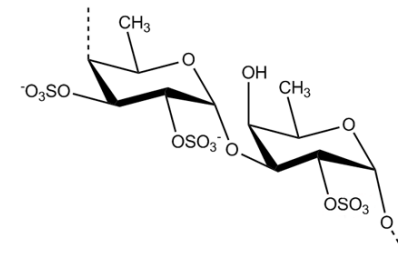
# BROWN ALGAE

- Extraction of antioxidants

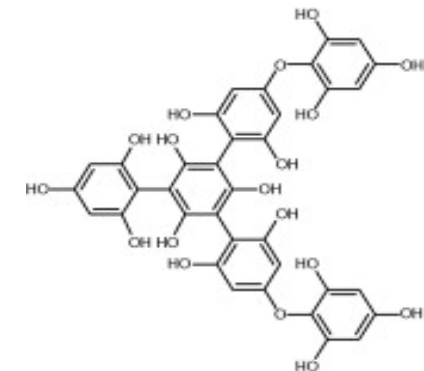
Xanthophylls (fucoxanthin)



## Sulphated polysaccharides



## Polyphenolic compounds



## Result → Healthy and sustainable products

# Bioactive compounds

*Fucus vesiculosus*



VS

*Saccharina latissima*



Bioactive compounds	<i>Fucus</i>	<i>Saccharina</i>
Polysaccharides	62-66%	38-61%
Protein	1.4-17%	3-21%
$\alpha$ -Tocopherol	38-73 mg/kg dw	0.1 mg/kg dw
Pigments (fucoxanthin)	340 mg/kg dw	-
Phenolic compounds	0.4-12.2%	0.2-5.3%

Source: Holdt & Kraan, 2011

**Antioxidant activity?**

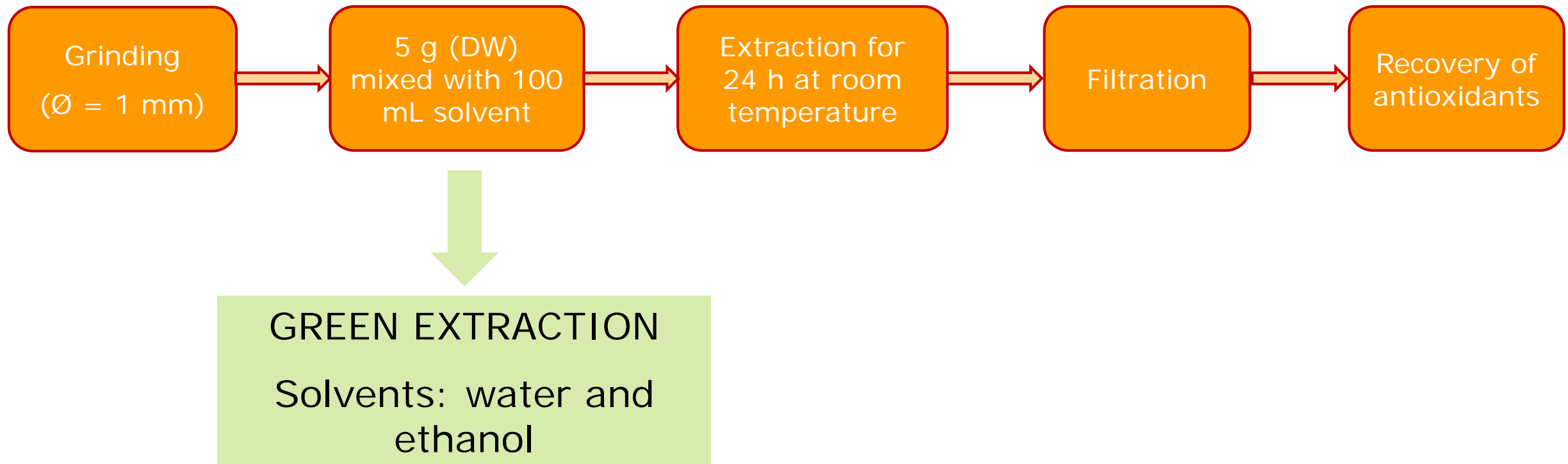


# Studies (S): Extraction of antioxidant from brown algae

## Tasks

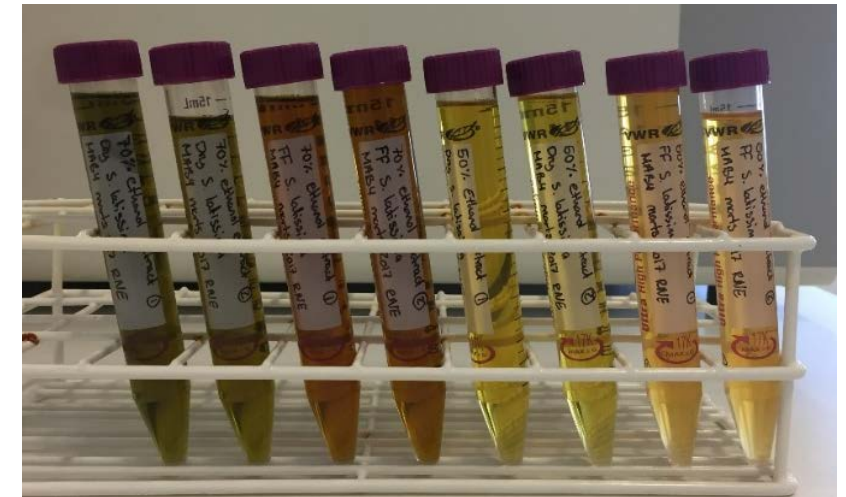
- Extraction of antioxidants from S1) *Fucus vesiculosus* (Danish) and S2) *Saccharina latissima* (Faroes)
- Determine the antioxidant composition of the extracts (major compounds)
- Evaluate the *in vitro* antioxidant properties of the extracts
- Evaluate the antioxidant efficacy of seaweed extracts in skin care model systems (facial cream)

# Extraction process (Solid Liquid Extraction)



# Extract overview

Study	Seaweed	Solvent	Code
S1	<i>Fucus vesiculosus</i>	Water	FWE
		80% ethanol	F80EE
S2	<i>Saccharina latissima</i>	Water	SWE
		50% ethanol	S50EE
		70% ethanol	S70EE



*S. latissima*, 70 and 50 % ethanol extracts

# Extract screening

## Total phenolic content and antioxidant properties (mean±sd)

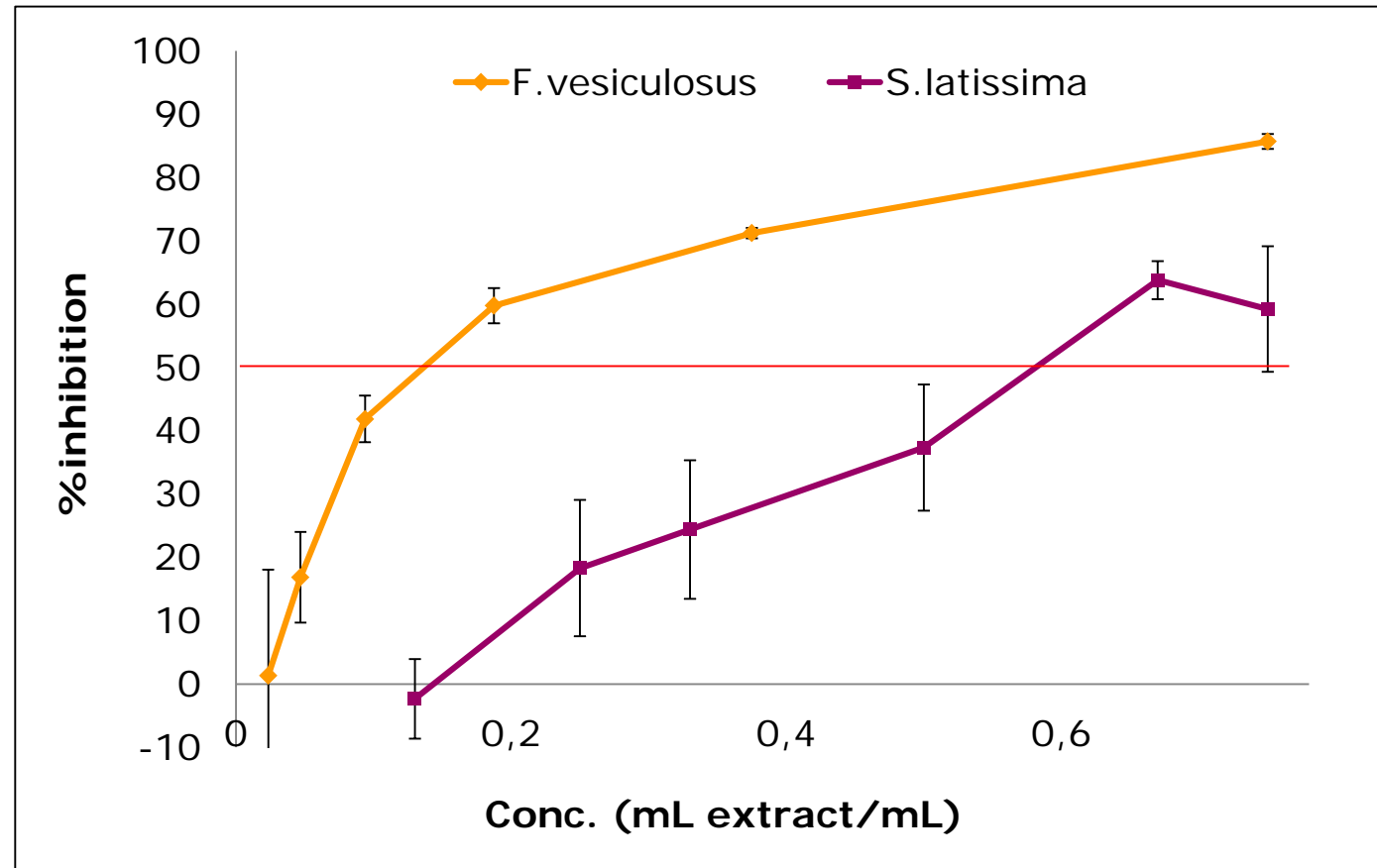
			TPC	Metal chelating ability		DPPH radical scavenging capacity		Reducing power	
Seaweed	Solvent	Code	TPC (mg GAE/L)	EC50 (mL/mL)	I <sub>max</sub> (%) *	EC50 (mL/mL)	I <sub>max</sub> (%) *	EC0.5 (mL/mL)	I <sub>max</sub> (Abs) *
<i>Fucus vesiculosus</i>	Water	FWE	867.2±34.9	0.12±0.03	90.7±3.5	4.2*10 <sup>-3</sup> ±0.2	89.5±3.1	0.4±0.1	1.7±0.2
	80% ethanol	F80EE	830.3±19.8	0.09±0.01	88.3±5.3	3.7*10 <sup>-3</sup> ±0.1	90.8±3.7	0.4±0.0	1.8±0.1
<i>Saccharina latissima</i>	Water	SWE	160.9±0.3	0.5±0.0	61.6±1.9	0.43	82.6±3.8	ND	0.4±0.0
	50% ethanol	S50EE	141.5±0.3	ND	29.1±7.5	0.34	82.6±3.8	ND	0.7±0.0
	70% ethanol	S70EE	111.8±0.0	ND	51.5±7.6	0.42	76.3±4.7	ND	0.5±0.0

\*Undiluted extract solution



# Metal chelating ability

*F. vesiculosus* vs *S. latissima* (water extracts)



# Chemical composition

## Pigments

	<i>Fucus vesiculosus</i>		<i>Saccharina latissima</i>		
Pigments (mg/100 g dw)	FWE	F80EE	SWE	S50EE	S70EE
Chlorophyll c3	nd	nd	nd	0.3±0.0	35.4±16.6
Chlorophyll c2	nd	6.8±0.7	nd	0.4±0.2	11.7±0.9
19-But- Fucoxanthin	nd	20.2±2.4	nd	nd	6.5±4.2
Fucoxanthin	nd	nd	nd	0.1±0.0	13.6±0.8
Lutein	nd	0.8±0.1	0.2	nd	nd
β-carotene	nd	0.6±0.4	3.4±0.1	nd	nd

# Storage trials



# S1

## *F. vesiculosus* added to facial cream formulation

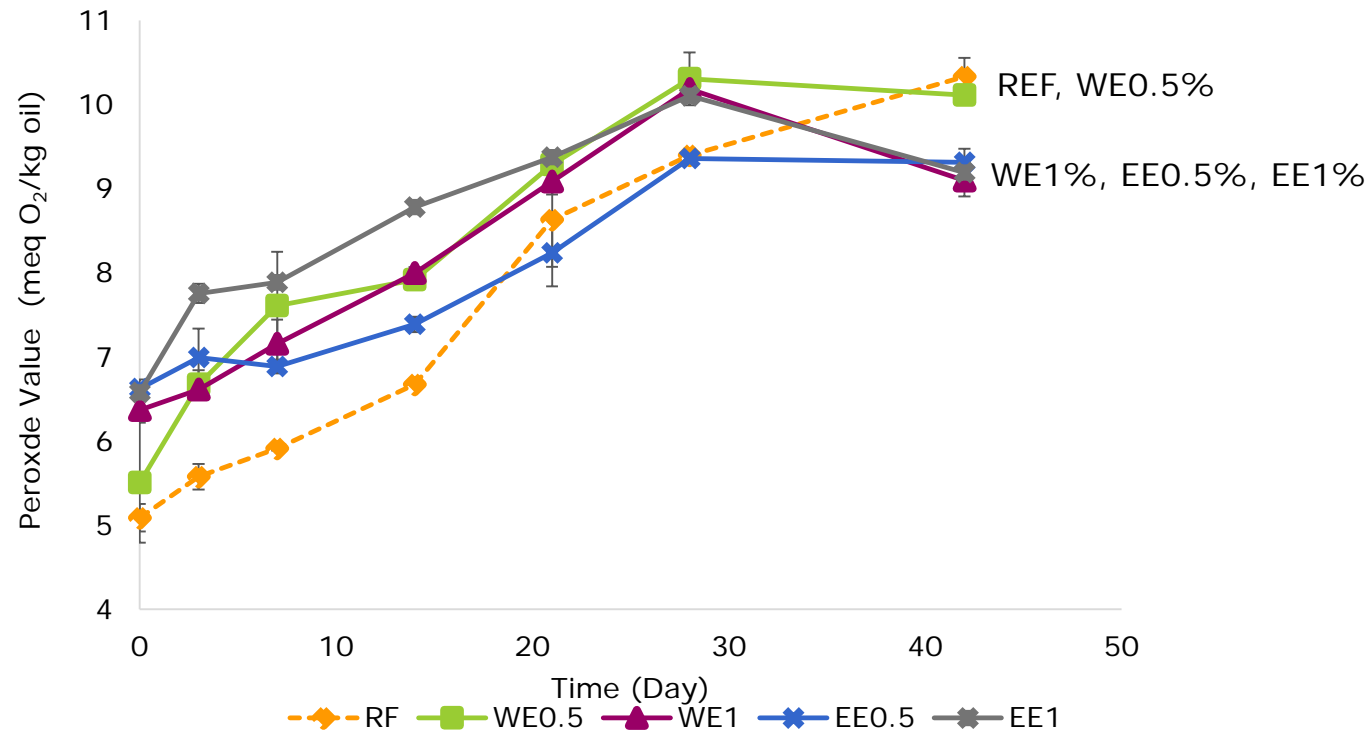
### Storage trial S1:

- 0.5 and 1% extract added (water or 80% (v/v) ethanol extract)
  - Samples: WE0.5, WE1, EE0.5 or EE1 (+REF without added extract)
- Storage for 42 days (dark, room temp)
- Determine oxidative stability: i.e fatty acid composition, peroxide value, secondary oxidation products, and tocopherols
- Almond oil and waxes used for the formulation:
  - 18:1: 54 %
  - 18:2: 18 %

# S1

## *F. vesiculosus* added to facial cream formulation

### Results: Peroxide value



- EE0.5, EE1 and WE1, had a significantly higher PV than REF at day 0
- Maximum PV at day 28 for samples with extracts
- Oxidation rate at day 28:
  - REF > EE0.5, EE1 and WE1

# S1

## *F. vesiculosus* added facial cream formulations

### Results: Secondary volatile oxidation products

Oxidation rate					
	REF	EE0.5	EE1	WE0.5	WE1
Heptanal	4.92%	-2.12%	1.82%	5.26%	1.04%
Hexanal	15.56%	7.81%	6.82%	15.76%	11.47%
2-Pentylfuran	86.28%	60.01%	72.42%	73.55%	68.25%

- Generally EE0.5 and EE1 had a lower oxidation rate compared with REF and cream added FWE
- Antioxidation effect
  - $EE1 > EE0.5 > WE1 > WE0.5 \approx REF$
  - EE1 showed the lowest oxidation rate for hexanal

# S1

## *F. vesiculosus* added facial cream formulation

Total Tocopherol Content			
	Day 0	Day 42	Percentage Change
unit	µg toc/g oil	µg toc/g oil	(%)
REF	5937 ± 307	5072 ± 383	-14.58 %
EE0.5	5155 ± 120	5292 ± 93.5	2.67 %
EE1	5379 ± 167	5440 ± 48.3	1.13 %
WE0.5	5432 ± 95.6	4950 ± 88.7	-8.87 %
WE1	6138 ± 9.66	5264 ± 82.9	-14.14 %

- REF and WE1: significant decrease in TTC between day 0 and 42
- No tocopherol consumption when ethanol extract was added
  - Phenolic compounds used before tocopherols?
  - A synergistic effect between tocopherol and phenolic compounds or pigments?
  - Regeneration of tocopherol?

# S2

## *S. Latissima* added to commercial cream

### Storage trial S2:

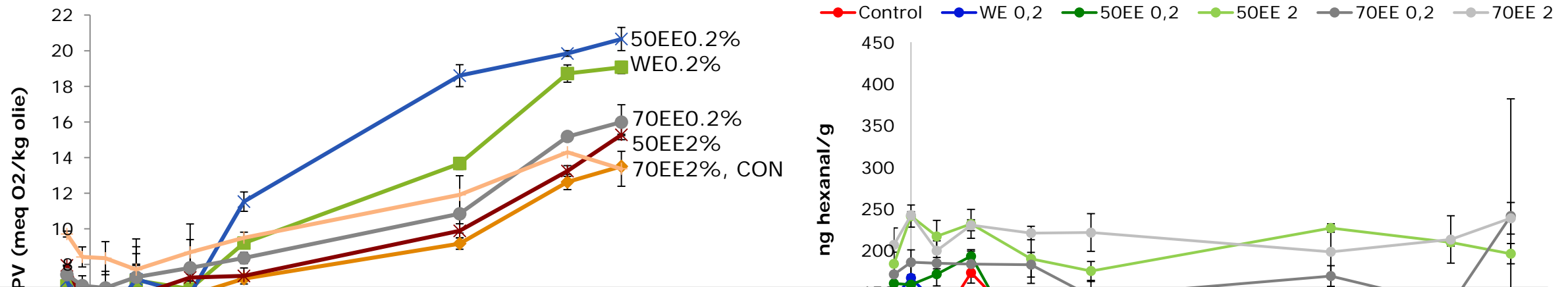
- 0.2 and 2% extract added (water, 50% or 70% (v/v) ethanol extract)
  - Samples: WE0.2, WE2, 50EE0.2, 50EE2, 70EE0.2 or 70EE2 (+CON without added extract)
- Abricot oil used in the creams:
  - 45 % 18:1 n-9
  - 15 % 18:2 n-6
- Storage for 70 days (dark, room temp)
- Determine oxidative stability
  - Fatty acid composition
  - Peroxide value
  - Secondary oxidation products
  - Tocopherol consumption
- Microbial contamination of WE2 (not included)



# S2

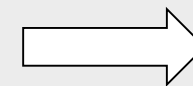
## *S. Latissima* added to commercial cream

Results: Peroxide value and secondary oxidation products (e.g. hexanal)



### Preliminary results

- No antioxidant protection of unsaturated fatty acids compared to control
- Prooxidant activity towards formation of primary oxidation products?
- No clear development in secondary oxidation products
- No consumption of  $\alpha$ -tocopherol during storage (not shown)



**The cream is stable**

# Conclusion

- Antioxidant was extracted from both types of seaweed with water and aqueous ethanol solutions using SLE.
- *F. vesiculosus* extracts was higher in TPC and *in vitro* antioxidant capacity compared with *S. latissima*
- Aqueous ethanol solutions extracted fucoxanthin from the seaweed
- Application of *F. vesiculosus* extracts improved the oxidative stability of the facial cream when stored in darkness → decreased formation of primary and secondary oxidation products
- No clear antioxidant activity of *S. latissima* in facial cream (cream itself was stable)
  - Accelerated oxidation studies are needed

# Acknowledgement



Susan L. Holdt



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DANISH  
TECHNOLOGICAL  
INSTITUTE



**Thank you!**